

**RECLAMATION
WORK**

OF THE

**Netherlands
Farms Co.**

BY

FRED H. TIBBETTS

REPRINT FROM

WESTERN ENGINEERING

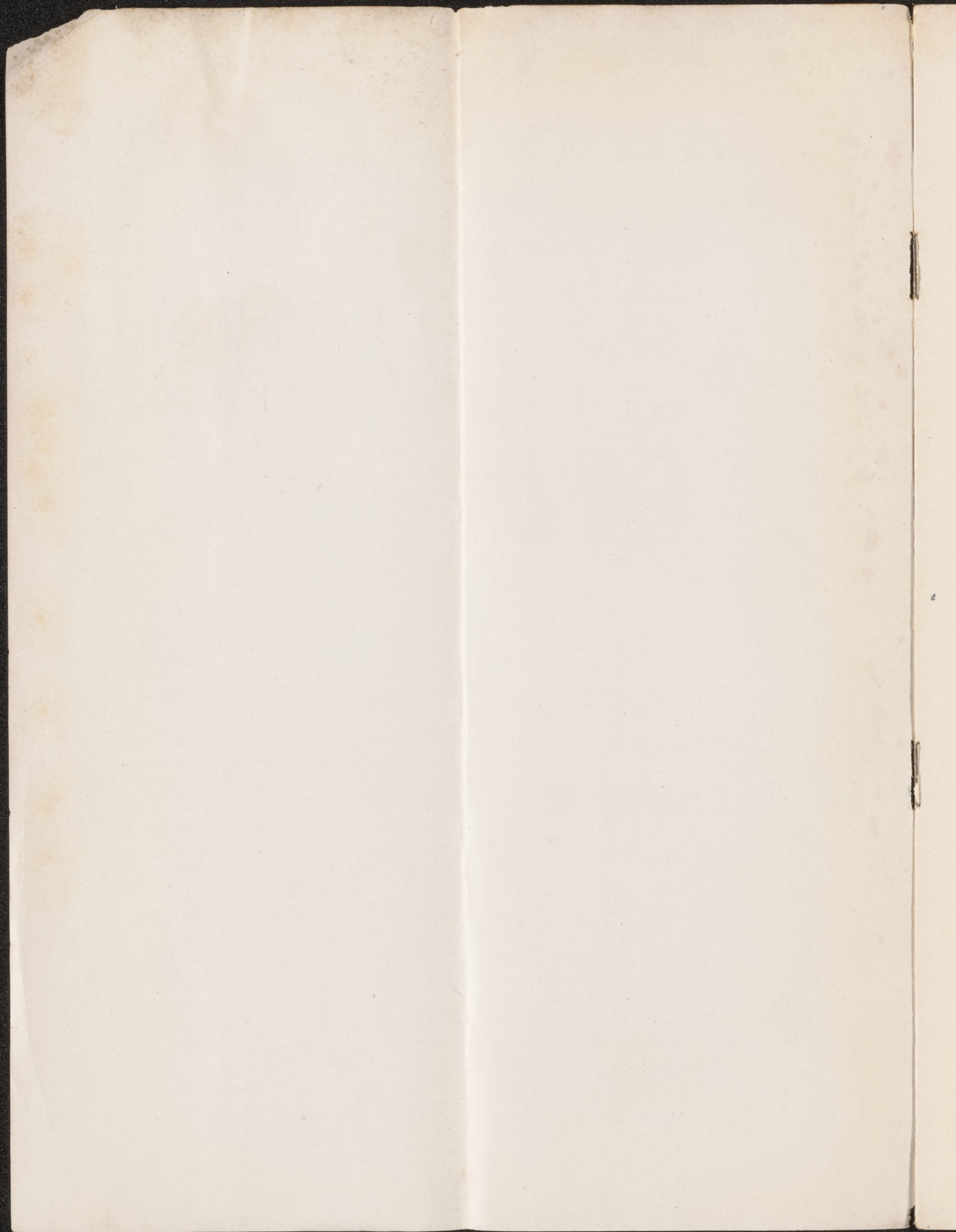
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Reclamation Work of the Netherlands Farms Company, Yolo Basin, California

By FRED H. TIBBETTS*

THE Netherlands Farms Co. is reclaiming the remaining overflow land in Yolo basin below Sacramento and east of the by-pass.† Yolo basin is the lowest and one of the largest of the great flood basins bordering the Sacramento river. Along all of these basins the river has a characteristic elevation of banks with depressed basins, or shallow troughs on either side, which is generally found with large rivers heavily laden with silt. The slope of the ground is generally rapid from the vicinity of the river toward the axis of the trough, which is from 2 to 7 miles distant, and depressed 6 to 12 ft. below the river banks. The Sacramento river borders the eastern edge of Yolo basin for about 75 miles. Along the eastern edge of the basin are a number of reclamation districts extending from the river a distance of 2 to 4 miles toward the trough of the basin. The mouth of the Feather river, the principal tributary to the Sacramento, is near the upper end of the basin, and near its centre is the mouth of the American river, another large tributary, and the city of Sacramento. From the Feather river to the lower end of Yolo basin, the Sacramento river is incapable of carrying more than a fifth of the flood water passing down the valley. The balance under the present general plan of flood control in the Sacramento valley must pass through Yolo basin in a large by-pass over 2 miles in width, the eastern edge

of which is now situated at an average distance of 3 to 4 miles west of the river. For about 10 miles either side of Sacramento the land between this by-pass and the river has been reclaimed. The remaining land at the south end of the by-pass forms the Netherlands Reclamation district containing nearly 30,000 acres.

At the time the Netherlands project was first conceived, the preliminary location of the by-pass was in the trough or lowest part of Yolo basin. This left a tract of not over 13,000 acres, too small to profitably reclaim. After a careful preliminary study of the problem, the conclusion was reached that if sufficient data were available this location would be shifted much farther westward so as to leave a much larger tract capable of economic reclamation. With this end in view an extensive preliminary survey was organized early in 1912. The result of this survey was a topographic map on a scale 1 in. to 1000 ft., with 1-ft. contours over practically the whole of Yolo basin south of the Southern Pacific railway track, a total area of over 100,000 acres. This work was prosecuted under extremely difficult conditions, as much of the land was covered with water, and with an exceedingly dense growth of high tules. A traverse was chained around the outer edge of the tract surveyed with one cross-line near the centre, and the whole carefully checked and balanced. Profiles were

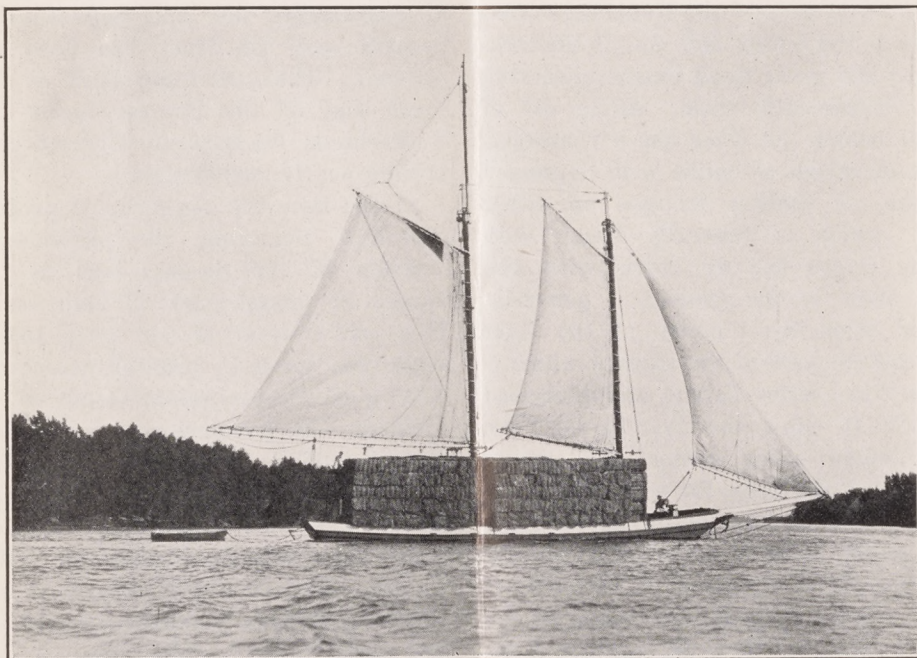
*Of Haviland, Dozier & Tibbetts, Consulting Engineers, San Francisco, California.

†See map on page 15.

then run across on east and west lines at 1-mile intervals. From these profiles stadia topography was taken generally by direct leveling with the transit measuring distances by stadia and angles by compass. In some cases 'tule wagons' were fixed with elevated platforms resting on the axles upon which transits could be set up high enough to overlook the tule. These were used in

ditches, and roads. Profiles compiled from this map are sufficiently accurate for location and construction purposes.

The principles governing the proper location of the Yolo basin by-pass were thoroughly studied by the consulting engineers of the State Reclamation Board, Major S. A. Cheney, of the California Débris Commission; W. F. McClure, State Engineer, and his assistant,



NAVIGABLE WATER ADJACENT TO NETHERLANDS PROJECT.

conjunction with rodmen mounted on horseback with 14-ft. stadia rods. The work was greatly retarded by the lack of transportation for surveying parties. The intense heat was also a difficult feature. To facilitate the work, a large house boat was purchased and fully equipped for headquarters for the surveying parties. Two gasoline launches and a number of smaller boats were used. The 1-ft. contour map is sufficiently accurate to serve as a basis for the location of levees, canals, drainage

E. A. Bailey, Flood Control Engineer. In general, the preliminary location of the channels was first established in the deepest portions of the flood basins with little reference to existing or probable improvements, or to the character of the land occupied. The by-passes are essentially large canals for the conveyance of water from one portion of the valley to portions lower down. Following conventional engineering practice, such canals are not usually located on a direct alignment from one end of a val-

ley to the other, but rather follow grade contours in order that the slope and velocity may be uniform and the tendency to silt reduced to a minimum. With the low velocities obtained in the by-passes it seems inevitable that slow silting will occur. Experience with the Elk Horn weir indicates the danger of sand and silt being thrown up over the sill of the easements proposed in the Yolo basin. The Yolo basin by-pass as finally located follows around the outer or western rim of the basin. The outer or western levee is thus located on high ground, and becomes much the smaller. In places the by-pass is so close to the western rim of the basin that it protects only a narrow margin of land so high that it will be flooded only for occasional brief periods during the few years that the by-passes reach their maximum discharge. In such cases it may be found advisable to omit the outer levee, and recompense the owners of adjacent land for the nominal damage caused by occasional flooding of their land for brief periods.

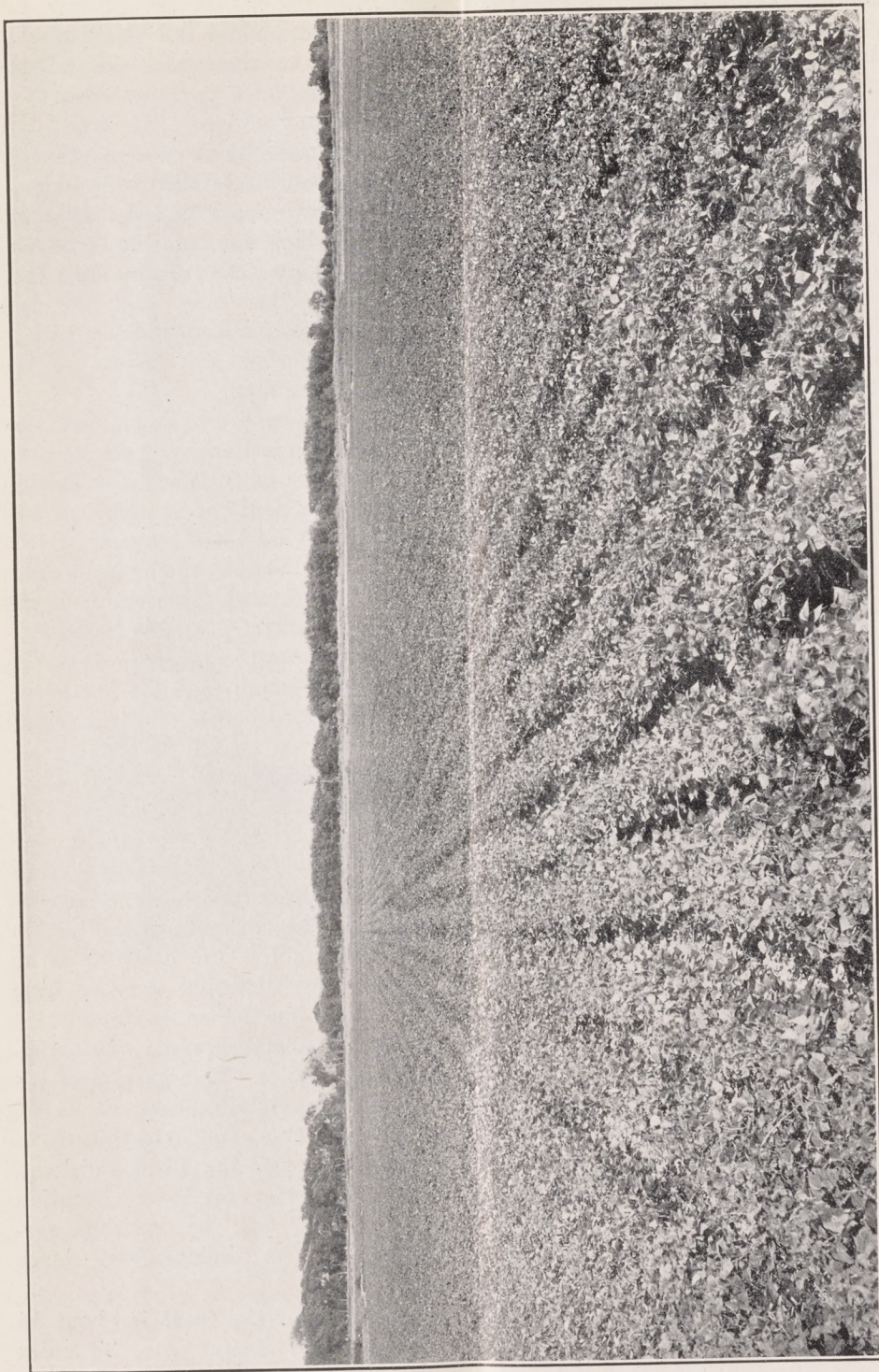
In the lower portion of Yolo basin there is a rank growth of tules from 3 to 7 ft. high, while toward the margin of the basin there is nothing but a sparse growth of very short grass. At the latitude of the Netherlands project the trough of Yolo basin is only a few feet above tide level, so that it is usually impractical to burn the tules except in alternate years when the dead growth of the preceding year is matted close to the ground. Even if burned, the green tule shoots may grow high enough in January and February to seriously obstruct the passage of floods in March. Wherever such tule growth exists, it is equivalent so far as water carrying capacity is concerned to raising the floor of the by-pass to the approximate height of the top of the tules.

The value of the land sacrificed in

the Yolo by-pass is exceedingly important. In general the better land is found on the riverward side of the trough, being built up by overflow from the river and sloughs. An exhaustive study was made by the state engineer's office founded on detailed soil analysis, to place the by-pass on the least valuable land which was found to be toward the western rim. The original and final location of the Yolo basin by-pass forming the western edge of the Netherlands reclamation are shown in the accompanying map.

The land proposed to be reclaimed by the Netherlands Farm Co. occupies all of the balance of the unreclaimed land in Yolo basin, south of Sacramento, and east of the Yolo basin by-pass. It extends for a distance of about 15 miles in a north and south direction, from the lower end of district No. 900 (West Sacramento Co.) to the upper or northern end of Ryer island. At the north end of the project are two relatively small areas, one west of the Glide district, and one west of the Lisbon district. The bulk of the land is between the Lisbon district and Ryer island, and consists of a large regularly shaped tract containing over 24,000 acres, with a length in a north and south direction of about 11 miles, and a width in an east and west direction varying from about 2 miles in the southern end to 4 miles in the northern end, and averaging about 3 miles. This portion of the total tract, containing between 24,000 and 25,000 acres, and lying south of Willow point and the Lisbon district, forms a separate unit for reclamation purposes, and will be entirely surrounded by an independent levee system.

The centre of the tract is about 14 miles south of Sacramento, 35 miles northwest of Stockton, and 63 miles northeast of San Francisco. It has a



CROP OF BEANS IN CENTRAL PORTION OF NETHERLANDS PROJECT.

frontage of about $1\frac{1}{4}$ miles on the Sacramento river, at the upper end, including the town of Clarksburg, and at the lower end it has a frontage of about $5\frac{2}{3}$ miles on Sutter and Miner sloughs, both of which are deep, navigable branches of the Sacramento river delta.

Topography

The head of the Sacramento delta was formerly at the northeast corner of the tract under discussion. The entire east side of the tract is bordered by the Sacramento river and by former delta branches, namely, Elk slough and Sutter slough. The south side is similarly bordered by Miner slough. Overflow from the banks of the river and from these sloughs has built up a margin of land about 6 to 7 ft. higher than the average level opposite. The land on this margin, however, slopes rapidly away from the river and sloughs, reaching the normal level of the basin in a distance of 1000 to 2000 ft. With the exception of this marginal strip of high land, the tract is remarkably level, with a barely perceptible slope not over 1 to 3 ft. from north to south. General ground elevations along the marginal fringe on the east and south sides vary from 7 to 14 ft. above low tide (U. S. E. D. Datum). The balance of the land, comprising probably 90% of the total, is at an elevation of from 5 to 7 ft. At the extreme northwest corner of the lower unit of the Netherlands, the delta of Babel slough has built up Willow point, a tract of land containing 100 or more acres, to a general elevation of 2 to 10 ft. higher than the surrounding land. Toward the north end of the project are two shallow lakes, containing several hundred acres. These are connected by winding sloughs which traverse the entire length of the tract in an irregular alignment near the cen-

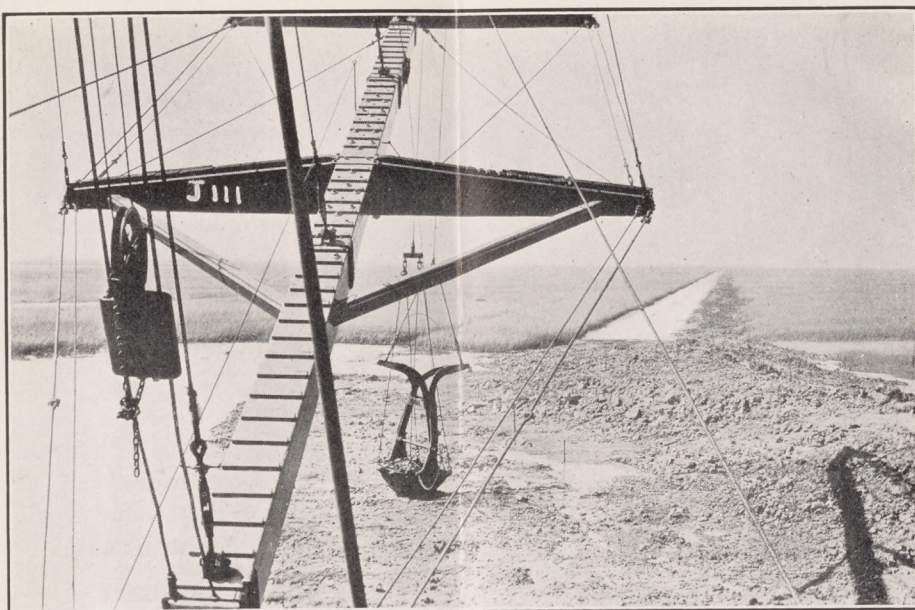
tre. These sloughs have been dug out at various times to permit the passage of dredges engaged on reclamation work in Yolo basin. The sloughs have numerous short winding branches continued in broad shallow depressions, 1 to 3 ft. in depth, which are quite numerous in nearly all portions of the tract. The main slough down which the dredges have worked is 40 ft. or more in width, with a low tide depth of 3 to 10 feet.

In its natural state, nearly all of the tract is covered with a heavy growth of tules, except for a narrow fringe of willows and cottonwoods, and underbrush on the high marginal land along the sloughs, and for some groves of large oaks near the north end.

Flood Conditions

Owing to the limited capacity of the Sacramento river, in extreme floods over 80% of the water coming down the valley must pass through Yolo basin. Under normal conditions the entire Netherlands tract is annually inundated during winter and spring floods, to a depth in places during severe floods, as great as 15 ft., though it is only in flood years that the high marginal land is flooded. As the Netherlands is near the extreme lower end of the flood plane of the Sacramento valley, the flood water drains off slowly and the lower portions of the tract are usually submerged for a number of months each season and until well into the summer. No use has ever been made of any of the land beyond occasional pasturage, except for very limited areas of high land, close to the sloughs, and near the upper end.

During the proceedings incident to securing from the State Reclamation Board permits for the levee construction desired by the Netherlands Farms Co., the location of the lower end of



BEGINNING OF BACK LEVEE CONSTRUCTION.



RIVER LEVEE CONSTRUCTION.

Yolo basin by-pass was definitely fixed and the extreme high water marks were determined within narrow limits. It is hence possible to predict with much certainty the maximum future flood heights at all points surrounding the proposed reclamation. The widths of the by-pass are not definitely fixed, but no probable change can make more than 1 ft. difference in the high water marks at any point adjacent to the Netherlands.

At present, flood conditions in lower Yolo basin are greatly aggravated by the narrow, restricted outlet of the Sacramento river from its mouth to Cache slough at the outlet of Yolo basin. Joint work is now under way by the State and the California Débris Commission, which will widen with large suction dredges the restricted sections. This work, which should progress rapidly, will afford much relief to flood conditions around the Netherlands.

Between the lower unit of the Netherlands and the Sacramento river, except for a distance of $1\frac{1}{4}$ miles at the upper end, are the excellent reclamations of Merritt, Sutter, Grand, and Ryer islands. The levee systems of these old reclaimed districts afford to the Netherlands a large amount of protection from the flood wave in the Sacramento river. Although their levees are lower and of more slender cross-section than those being built for the Netherlands, they have proved among the best reclamations in the Sacramento valley. The first three, especially, have not been inundated for many years. It is possible that the back levee of Merritt island may be strengthened and used for a portion of the east levee of the Netherlands Farms Company's project.

Proposed Levee System

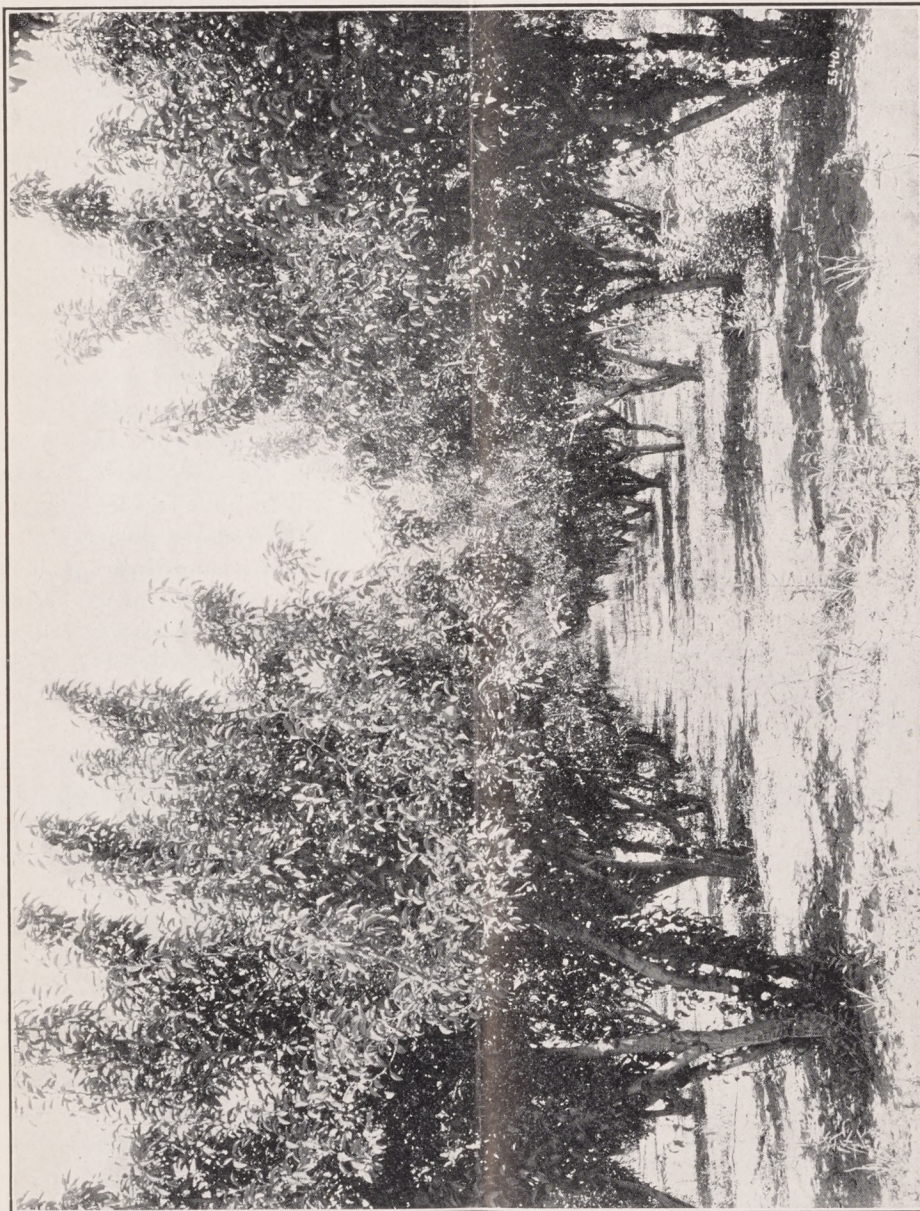
It is proposed to secure protection from flood waters for the lower unit of the Netherlands by entirely surrounding it with an unbroken and massive system. Seepage and drainage water will then be controlled by means of drainage canals and laterals, and by a large pumping plant at the lower corner of the district. The proposed levee system consists of $31\frac{1}{3}$ miles of levees, with a total volume of approximately 8,000,000 cu. yd. In order that the district may be certainly protected in the event of the failure of levees of adjacent reclamations, it is proposed to provide at the north end a continuous cross-levee, including the south levee of the Lisbon district, from the Sacramento river to the Yolo basin by-pass. This levee will be built to such a height that it will afford ample protection under any possible conditions of levee failure on the river to the north. If the back levee of Merritt island is utilized for a portion of the east levee of the Netherlands, the same precaution will be observed.

The grades on all levees are fixed at least 6 ft. above the maximum estimated high water marks. This requirement, which is unusually conservative, is provided on the back levees, because of the possible exposure to wave wash, and on the river and slough levees, because of some uncertainty regarding the exact maximum height of the flood plane under conditions liable to develop during the construction of the Débris Commission project for flood control. The west, or back levee, especially, is being built more massive and larger than any, of which the writer has knowledge, constructed for similar purposes. The levees along the

sloughs also have heavy cross-sections, but as they are situated on higher ground they are not so large. The actual and final estimated high water

along the front and rear of the project are not greatly different.

The ground to be occupied by the levees, except where it is impracticable



PEAR ORCHARD ON THE PETERSON PLACE NEAR SOUTH END OF NETHERLANDS PROJECT.

marks are but little higher at points on the river and sloughs than at points in the basin opposite, and hence actual elevations of the crests of the levees

to do so on account of water, is being thoroughly cleared and plowed, and where occupied by trees or brush, the stumps are pulled and grubbed. This

precaution insures a continuous bond between the levee base and its foundation and reduces seepage to a minimum. All levees, except the river levee, will have at their axes a muck ditch, dug into the original ground surface, at least 6 ft. in depth in order that all lines of weakness in the foundation of the levees may be intercepted, the seepage reduced, and the levee firmly keyed to the natural ground surface. In the case of the back levee, the muck ditch has been dug with small ditchers, and in the case of the slough levees it will be dug with traction ditchers or teams. A berm of undisturbed material at the natural ground surface at least 30 ft. in width is provided in all cases between the outer toe of the levee and the inner edge of the borrow pit. This checks sloughing of the outer surface of the levee and prevents the concentration of destructive currents along the levee. It also prevents caving of the banks of the borrow pit from reaching the levee section. All levees are being constructed with large clam-shell dredges from material obtained from borrow pits or canals paralleling the levees. The levees are being carefully built up in layers in order that there may be no undue settlement or sloughing of material outside of the desired cross-section. The Willow Point cross-levee and the back levee where there is a possibility of exposure to wave wash will be protected by a heavy growth of willows, planted on the outer slope of the levees and on the opposite side of the borrow pits. Protection from wave wash will be secured by planting the outer slope with willows or swamp cypress at the corners of 5 ft. squares. In addition to this protection, a break water mound is to be provided, 4 ft. in height, with a 6-ft. top width, and 1 on 3 side slopes. On this mound are to be

planted four rows of willows or swamp cypress. Experience has shown that willows will grow rapidly on a mound elevated as much as this above the general surface of the overflow land. Willows and brush for breaking waves are more efficient, if situated some distance, in this case over 200 ft. from the slope. The deep borrow pit will tend to concentrate the water so that it will have a swift and distinct current, parallel to the levee, sufficient to be quite effective in breaking waves, but not sufficient to endanger the levee from erosion. The river levees where required will be protected from steamer wash and direct current scour by standard pile and brush protection.

Estimates of cost have been prepared according to the tabulation following.

Cost Estimates

The cost estimates are based on the following unit prices:

Levee construction:

River levees, 6c per cu. yd.

Slough levees, 7c per cu. yd.

Back levee, 8c per cu. yd.

Muck ditch, 25c per cu. yd.

Clearing, \$70 per acre.

Plowing, \$10 per acre.

Planting willows, 5c each.

Piling and brush bank protection, \$2.75 per lin. ft.

The above costs are exclusive of engineering or administration, but 10% is added for incidentals. On this basis the total estimated cost for levee work on the lower unit of 24,337.8 acres, is \$738,860 or about \$31.50 per net acre.

The total cost, including the foregoing expenditures, and for drainage, purchase price of land, interest during construction, and for improvements necessary to reclaim the land completely and in a shape to market, is estimated at approximately \$100 per acre.

Drainage

Detailed plans for drainage of this tract have not as yet been completed. The essential feature, however, would be the utilization and enlargement of the large slough now extending longitudinally through the centre of the tract. Drainage laterals at $\frac{1}{2}$ -mile intervals will conduct seepage and rain water to this main canal. At the lower end, and near the southwest corner of

end tide gates will also be installed to permit of the automatic lowering of the water-level in the main drainage canal to the level of low tide. It is estimated that the drainage work will cost about \$10 per acre.

Subdivision

The entire tract will be subdivided into small farms of approximately 10 to 40 acres in size. It is probable that three townsites will be laid out, one on



LOOKING NORTHWARD UP DUCK SLOUGH ABOUT $2\frac{1}{2}$ MILES WEST OF COURTLAND.

the project, a pumping plant will be erected with a capacity of about 200,000 gallons per minute. This will consist of four equal units of 42-in. centrifugal pumps direct connected to horizontal two-speed electric motors. They will pump water through the levees into the by-pass. The plant will be arranged so that water can be siphoned into the district in the reverse direction if desired. A part of the drainage system control gates will also be placed which will make it possible to admit water from the river near the upper end of the project, or from Miner slough, near the lower end of the project. At the lower

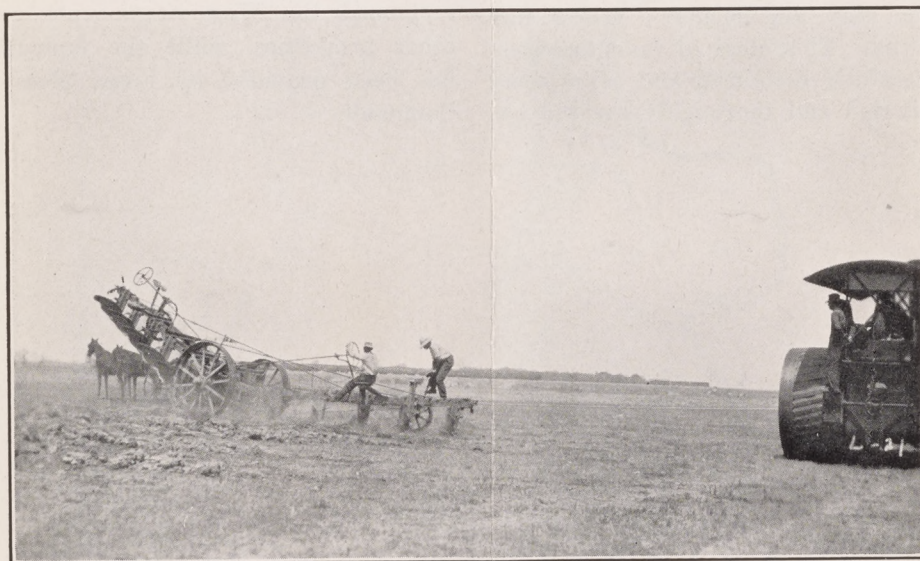
the river at the northeast corner of the project, one on the eastern edge of the project near the centre and about $\frac{1}{2}$ mile from the river with which it will be connected by the deep navigable channel of Sutter slough, and one at the southeast corner of the project at the junction of Miner and Sutter sloughs, both of which are navigable. The West Side Electric railroad is laid out longitudinally through the project near the centre, and provides quick transportation for each of the townsites, and for the entire district. A very careful study has been made of the subdivision in order that main di-

agonal roads may be laid out so as to give quick and direct transportation from every farm to the nearest town-site.

Time of Completion

The permit of the State Reclamation Board granted permission for the construction of the Netherlands levees and contains a limitation that the levees be not closed prior to the spring of 1914. It should be possible to close the levees

forced too fast without having material slide outside of the cross-section, increasing the bulk of the levee beyond the estimated amount, and making it difficult to raise it to grade. As the slough levees are of more moderate size, and the borrow pits are all at tide water level, and readily accessible to the Sacramento river, construction work can progress at any time, and with any number of dredges found most convenient. It should be possible to



BREAKING NEWLY RECLAIMED LAND WITH STEAM PLOWS.

promptly at the expiration of the date set, and to a height sufficient to afford protection during any normal flood for the winter of 1914 or 1915. The time of final completion will depend upon the rate of progress which it is possible to maintain on the heavy back levee.

From four to six dredges are now continuously engaged on the back levee. The muck ditch is entirely complete, portions of it on high ground having been constructed by road excavators, but the most of it by small clam-shell ditching machines. As the cross-section of the main levee is unusually high and massive, it cannot be

close the back levees above high water marks during the fall of 1914, and to hold the levees against any probable floods with the aid of the large dredges which will be working during the winter of 1914-1915. It will be easy to keep other features of development at a more advanced stage, so that the property should be available for disposal in the spring of 1915, and might be available for disposal but hardly for settlement in the summer of 1914.

Soil

The soil of the Netherlands Farms Co. has been formed largely by material

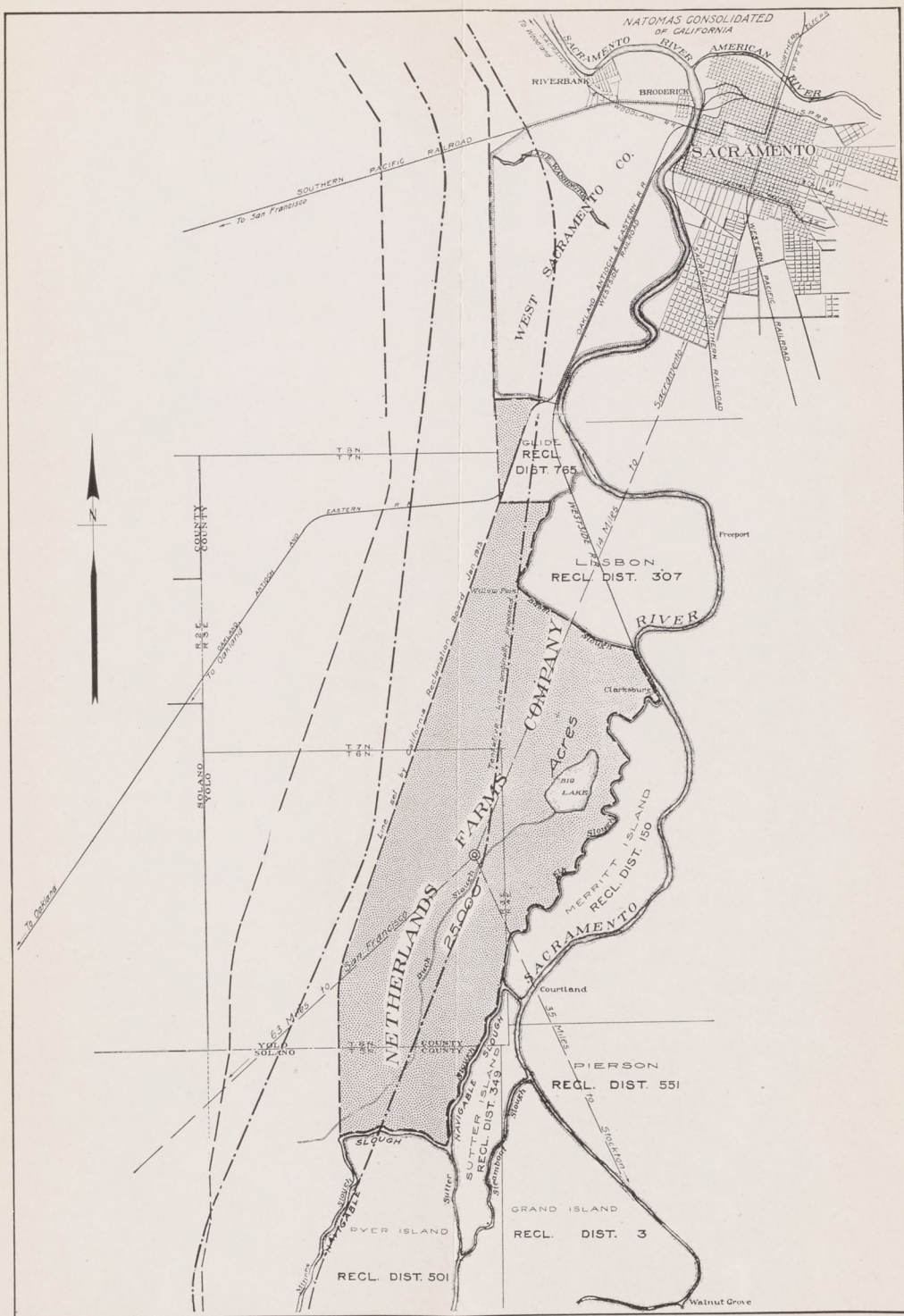
carried in suspension by the flood waters of the Sacramento river and deposited for many years past. The texture of the greater portion of the soil is clay loam, mixed with fine sand and humus. The soil in the eastern half of the tract is strictly what is known as 'general purpose soil,' as in this half the alluvial sediment and tule decay is deeper. At present the top layer of the soil stratification consists of a soft tule mud with an average thickness of about 5 to 12 feet. Underlying this is a blue clay, and deeper, a yellow clay stratum. This class of land has been successfully reclaimed and after being cultivated and thoroughly aerated has

proved to be of a most highly productive type.

Lands in adjoining reclaimed districts are in a state of high cultivation, and sell at prices ranging between \$300 and \$400 per acre, depending on location and state of cultivation.

Management

The working out of this project is under the direction of the same experienced interests which have successfully reclaimed the West Sacramento and other properties, while the financing has been provided by Louis Sloss & Company.



MAP OF NETHERLANDS FARMS CO., YOLO AND SOLANO COUNTIES, CALIFORNIA.

